Proton-Proton Correlation in 158 A·GeV Pb+Pb Collisions

F. Wang, P. Jacobs and the NA49 collaboration

The proton-proton correlation function pins down the freeze-out volume of protons, which when compared to that of pions via HBT gives important information on the evolution dynamics of heavy ion collisions. The correlation is produced by final state interactions (attractive S-wave strong interaction and repulsive Coulomb interaction) and Pauli exclusion. The combination of these generates a peak in the correlation function at $q_{inv} = \frac{1}{2}\sqrt{-p^{\mu}p_{\mu}} \simeq 20$ MeV/c. The proton-proton correlation function is unique in that the position of the peak is fixed, but its height is inversely proportional to the spatial and temporal extent of the source from which the protons are emitted.[1]

We have measured the proton-proton correlation function in central Pb+Pb collisions at 158 GeV/c per nucleon in the NA49 experiment. Particles are detected by two vertex time projection chambers (VTPCs) in the magnetic field and two main time projection chambers (MTPCs) down-stream of the magnetic field. A good track candidate must have track segments in one of the MTPCs and at least one of the VTPCs. The protons are selected according to the amount of ionization energy (dE/dx) deposited in the MTPCs, which have dE/dx resolution $\sigma \simeq 5\%$. Since the proton mean dE/dx is only 1σ and 3σ away from those of kaons and pions with similar momentum, protons must be selected on statistical basis. Tracks with at least 70% probability to be proton are included in the analysis.

The correlation function is formed by taking the ratio of the number of true and background pairs in a q_{inv} bin. Background pairs are formed by paring particles from different events. For each event, the previous 50 events are used to form background pairs, in order to have factor of ~100 more statistics than the true pairs. Two track resolution in the MTPCs is typically 2 cm; a cut of 3 cm is imposed on both the true and the background pairs in the analysis. The resulting correlation function is shown in the upper panel of the figure. The normalization is such that the correlation function is unitary at large q_{inv}. The pair statistics are shown in the lower panel of the figure. In order to extract the collision source size, one has to use a transport model as input to simulate the correlation function. Study with Venus model is in progress.

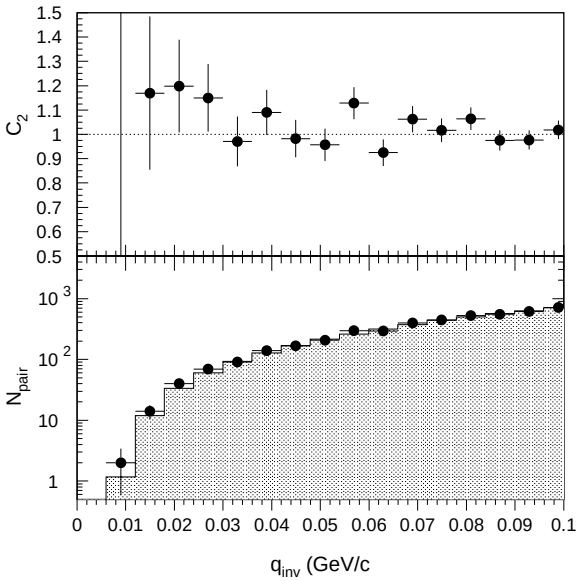

Figure 1: [top] Proton-proton correlation function. [bottom] Pair statistics and normalized background.

Two main sources of contamination in the proton sample used in the analysis are pions and kaons on the lower tails of their dE/dx peaks merging into the region with at least 70% protons, and protons from lambda decays that are detected and appear to come from the primary vertex[2] with the correct dE/dx. Studies of these sources of contamination are underway.

Footnotes and References

[1] S.E. Koonin, *Phys. Lett.* **70B** 43–47 (1977).
C. Gelbke and B.K. Jennings, *Rev. Mod. Phys.* **62** 553–602 (1990).

Footnotes and References

[2] M. Toy *et al*, elsewhere in this report.